
Two New Species of *Brachymenium* (Bryaceae) from Central America, with a Key to the Species of *Brachymenium* in Central America

Bruce Allen

Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A.

ABSTRACT. *Brachymenium debilinerve* differs from *B. speciosum* by its dark green color, weak costa, well-spaced, flat, caducous leaves having numerous quadrate alar cells, and a weakly developed limbidium. *Brachymenium exoticosporum* differs from all members of the genus in having massive, mostly linear, endosporic protonemata with mostly vertical end-walls. The endosporic protonemata of *B. exoticosporum* appear similar to those found in *Ephemeropsis trentepohlioides*. A key to the 16 species of *Brachymenium* in Central America is given.

Brachymenium is a mostly tropical or subtropical genus of about 70 species (Ochi, 1992). Nearly all *Brachymenium* species have hexagonal to rhomboidal upper leaf cells, excurrent costae, and apiculate to hair-pointed leaves. Many of the common species also have quadrate basal leaf cells. The *Brachymenium* gametophyte is mostly indistinct, and sterile material can be difficult to distinguish from *Bryum* or *Acidodontium*. The *Brachymenium* sporophyte has erect to suberect capsules with conic-apiculate to short-beaked opercula. Its peristome is diplolepidous with narrow, densely papillose exostome teeth and a reduced endostome. The *Brachymenium* endostome has a high or low basal membrane with the segments and cilia generally rudimentary to absent. When the segments and cilia are rudimentary, they are morphologically identical and as such the two structures can be identified only by their position relative to the exostome teeth. This endostome condition is often termed erose. A good example of the loss of segment/cilia differentiation in *Brachymenium* occurs in the bizarre endostome of *B. columbicum* (De Notaris) Brotherus (see Shaw, 1984). This endostome has a high basal membrane from which arise 16 morphologically similar, lanceolate structures. Each lanceolate structure is positioned opposite an exostome tooth and represents a cilia/segment complex consisting of 4 fused parts: 2 cilia (in the center of the linear structure) with $\frac{1}{2}$ of a segment on either side.

Brachymenium has been divided into five sections (see Ochi, 1980, 1992) based on features such

as plant size, operculum shape, capsule shape and size, spore size, limbate condition of the leaves, and peristome structure. The sections, however, have species with reticulating character combinations that serve as intermediates between the sections, making it sometimes difficult to separate them (Ochi, 1980). Some of the present sectional characteristics may be of minor phylogenetic importance (i.e., plant and capsule size, presence or absence of leaf border), and an analysis of the genus focusing on more reliable features (i.e., exostome and endostome morphology, spore size, basal leaf cell shape) within the context of an in-depth sister-group character analysis is needed before a more natural subgeneric classification can be proposed.

There are 16 species of *Brachymenium* in Central America, 2 of which are described below as new to science, in preparation for the next volume of the *Moss Flora of Central America* (Allen, 1994).

***Brachymenium debilinerve* B. H. Allen, sp. nov.**

TYPE: Panama. Chiriquí: Fortuna Dam region, along trail to Cerro Hornito (Pate de Macho) on southern ridge of watershed, 8°45'N, 82°15'W, 1800–1950 m, *McPherson 13595D* (holotype, MO; isotype, PMA). Figure 1A–H.

A *B. specioso* (Hooker f. & Wilson) Steere foliis atrovirentibus, planis, caducis, limbidio debili, cellulis alaribus quadratis, costaque debili differt.

Plants large, dark green, in loose tufts, moderately tomentose below. Stems to 30 mm long, epidermal cells rectangular, rhizoids reddish brown, papillose. Leaves equally foliate, distantly spaced, 3–5 mm long, erect-flexuous, at times weakly twisted, erect-spreading when wet, plane, ovate to oblong-lanceolate, long-acuminate, often asymmetrically curved above, margins not or faintly and indistinctly bordered by 1–2 rows of somewhat longer, narrower cells, entire below, serrate to denticulate above, the teeth single or occasionally double, plane; costa thick at base and tapering above, $\frac{1}{2}$ to $\frac{2}{3}$ the leaf length; cells firm-walled throughout, sometimes porose, upper cells long-rhomboidal,

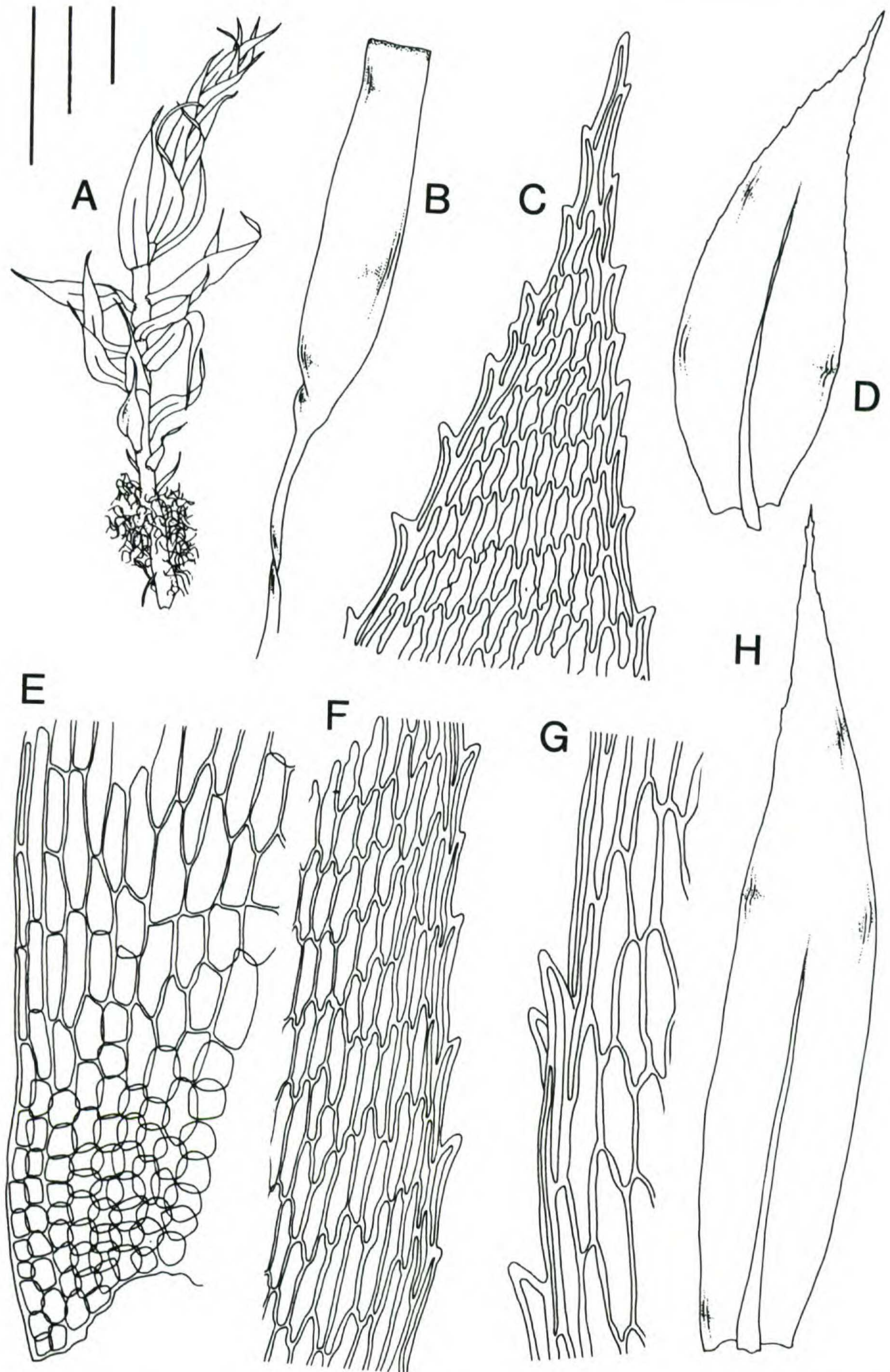


Figure 1. *Brachymenium debilinerve* B. H. Allen. —A. Habit. —B. Capsule. —C. Leaf apex and upper leaf cells. —D & H. Leaves. —E. Basal cells in alar region. —F. Leaf margin and median leaf cells. —G. Leaf margin showing occasional double toothing. Scales in mm: left = 0.5 (B); middle = 0.5 (D, H); middle = 0.1 (C, E, F); middle = 0.05 (G); right = 2.0 (A).

60–120 × 16–20 μm, basal cells quadrate. Dioicous. Setae 20–25 mm long, red. Capsules 5–6 mm long, cylindrical, constricted at neck, erect; annulus not seen, opercula not seen; peristome badly eroded, only remnants of exostome and endostome present. Calyptrae not seen. Spores 10–16 μm, spherical, smooth to lightly roughened.

Habitat. On tree trunks and branches; 1800–1950 m.

Brachymenium debilinerve is a large *Brachymenium* species very similar to *B. speciosum* (Hooker f. & Wilson) Steere. Both differ from all other Central American species of *Brachymenium* by the combination of their large size, extremely long leaf cells, and occasionally, doubly toothed leaf margins. *Brachymenium debilinerve* is marked by its dark green color, weak costa, well-spaced, flat, caducous leaves having numerous quadrate alar cells, and a very weakly developed limbidium. In contrast, *B. speciosum* is yellowish green, has percurrent to shortly excurrent costae, and closely spaced, persistent leaves with rectangular alar cells that are distinctively bordered by 3–4 rows of linear, thick-walled cells. *Brachymenium debilinerve* is known from Costa Rica (Guanacaste: *Dauphin 1833* (CR, MO); Puntarenas: *Dauphin 1454* (CR, MO)) and Panama.

Brachymenium exoticosporum B. H. Allen, sp. nov. TYPE: Panama. Chiriquí and Bocas del Toro: ridge top N of Cerro Pate Macho, ca. 5 km NE of Boquete above Palo Alto area, 8°48'N, 82°24'W, 1950–2200 m, *Hammel, Grayum, McPherson & Smith 14404* (holotype, MO; isotype, PMA). Figure 2A–I.

Species protonematibus endosporis grandibus linearibus, setisque longissimis a congeneribus differt.

Plants medium to large, yellowish green, shiny, in loose, open tufts, tomentose below. Stems to 30 mm long, epidermal cells rectangular, rhizoids reddish brown, papillose. Leaves distantly spaced and equally foliate, 3–5 mm long, flexuous-spreading when dry, erect-spreading when wet, concave, oblong-elliptic to ovate, acuminate, ending in denticulate points, margins distinctly bordered by several rows of linear, thick-walled cells, entire below, serrate to denticulate above, teeth single or occasionally double, reflexed at base, plane above; costa tapering to the apex, shortly excurrent into the hair-point; cells firm-walled throughout, porose, upper cells long-rhomboidal, 40–70 × 20–24 μm, basal cells rectangular, 30–50 × 16–20 μm. Perichaetial leaves strongly differentiated, triangular-lanceolate

to lanceolate, 5 mm long. Dioicous. Setae to 65 mm long, yellowish red to orange. Capsules to 7 mm long, cupulate, neck to 3 mm long, abruptly constricted, erect; operculum not seen; exostome teeth linear-lanceolate, red below, whitish above, densely papillose, endostome whitish, papillose, basal membrane short, segments and cilia rudimentary to absent. Calyptrae not seen. Spores 40–56 μm, thin-walled, oblong, lightly roughened. Endosporic protonemata filling the capsule, linear, multicellular, mostly uniseriate, 240–320 μm × 50–60 μm.

Habitat. Epiphyte on tree branches in forest on ridge; 1950–2200 m.

Brachymenium exoticosporum, known only from the type, is a robust species with distantly spaced, flexuous leaves that are distinctly bordered and sharply serrate; the marginal teeth at times are double. In its distantly spaced leaves it resembles *B. debilinerve* but that species has flat leaves, a short costa (½–⅔ the leaf length) and very weak to absent leaf limbidia. It is also gametophytically close to *B. speciosum*, but that species differs in its longer leaf cells (80–120 μm long). The outstanding features of *B. exoticosporum* are found in the unusually large size of its sporophytes and its massive endosporic protonemata. Although the spores of *B. exoticosporum* are also large, there are several *Brachymenium* species that have spores nearly as big (*B. consimile* (Mitten) Jaeger, 20–30 μm; *B. radiculosum* (Schwaegrichen) Hampe, 22–30 μm; *B. spirifolium* (C. Müller) Jaeger, 30–40 μm), and one species (*B. standleyi* Bartram, 20–80 μm) has larger spores. There are relatively few spores in the capsules of *B. exoticosporum*, and many of these appear inviable because they have collapsed spore walls. Most of the capsule contents consist of large, linear, multicellular structures that represent endosporically germinated protonemata. This is the first report of massive, endosporic protonemata in *Brachymenium*. The endosporic protonemata have mostly vertical end-walls. Occasionally these structures have horizontal or oblique walls, and sometimes they are irregularly rounded with cell walls in all planes.

Endosporically germinated protonemata are a rare feature randomly distributed among mosses. Allen (1987) postulated that these structures may be ecologically adaptive since they have been found to shorten the time between diaspore release and leafy gametophyte formation. Most endosporic protonemata are more or less globose and/or multiseriate in structure. The endosporic protonemata of *B. exoticosporum* resemble more or less uniseriate gemmae and appear similar to the type found

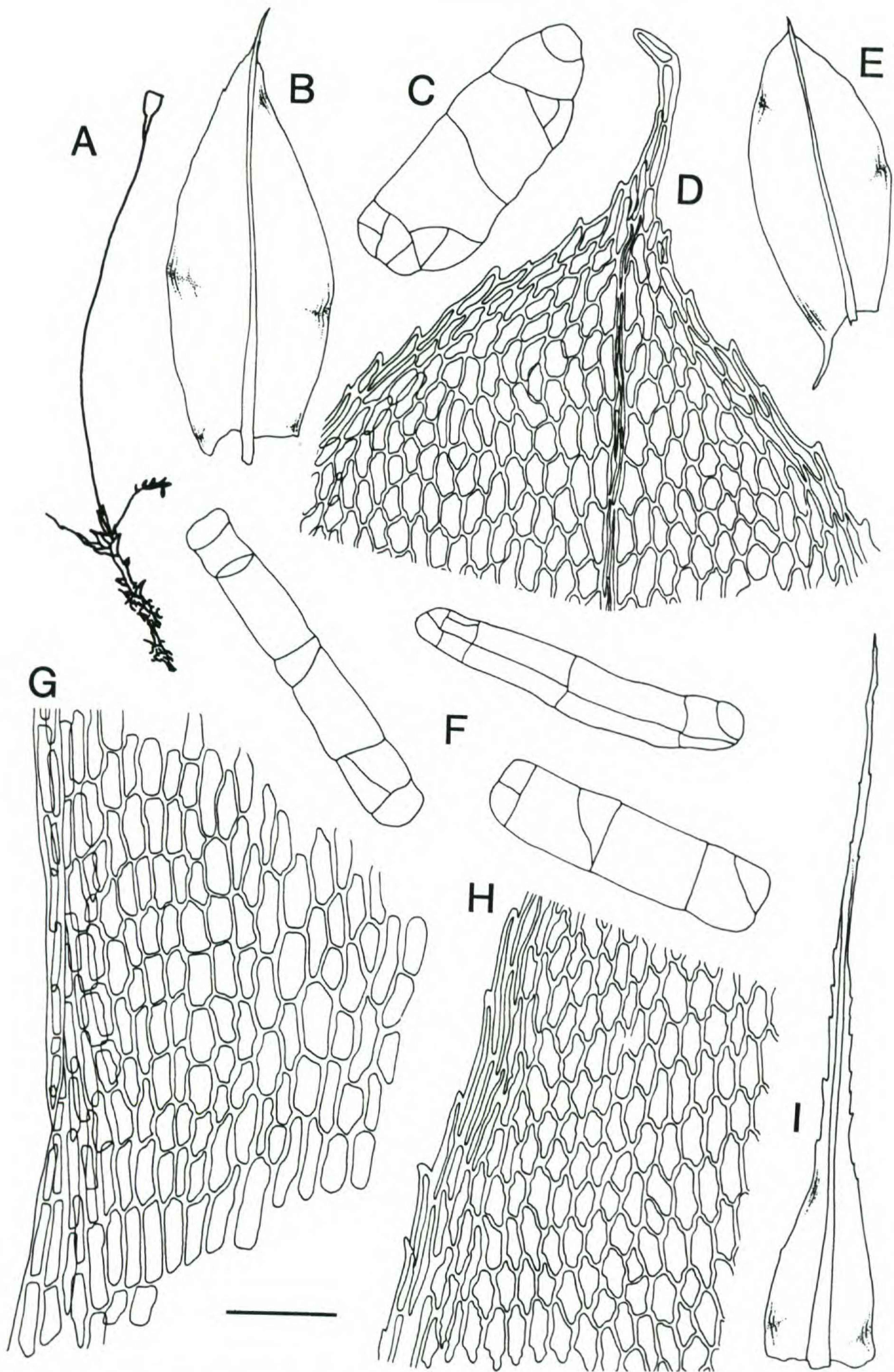


Figure 2. *Brachymenium exoticosporum* B. H. Allen. —A. Habit. —B & E. Vegetative leaves. —C & F. Endosporic protonemata. —D. Leaf apex and upper leaf cells. —G. Basal cells in alar region. —H. Leaf margin and median leaf cells. —I. Perichaetial leaf. Scale in mm: = 0.1 (C, D, F, G, H); = 0.5 (I); = 1.0 (B, E). Habit (A) drawn full-sized.

in *Ephemeropsis trentepohlioides* (Renner) Sainsbury (Sainsbury, 1955).

Key the Species of *Brachymerium* in Central America

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| <p>1. Plants minute; leaves less than 1.0 mm long 2</p> <p>1. Plants small to large; leaves greater than 1.2 mm long 3</p> <p>2(1). Leaf cells lax and thin-walled throughout, upper cells elongate, alar cells short rectangular; leaves bordered by long, narrow cells
 <i>B. acuminatum</i> Harvey</p> <p>2. Leaf cells firm and thick-walled throughout, upper cells rhombic, alar cells quadrate; leaves bordered by short-rectangular cells
 <i>B. exile</i> (Dozy & Molkenboer) Boch & Lacoste</p> <p>3(1). Leaves caducous; costa from 1/2–2/3 the leaf length <i>B. debilinerve</i> B. H. Allen</p> <p>3. Leaves firmly attached to stem; costa percurrent to excurrent 4</p> <p>4(3). Leaves not or indistinctly bordered 5</p> <p>4. Leaves distinctly bordered 9</p> <p>5(4). Leaves hair-pointed, the hair point entirely or in part hyaline, often 1/2–3/4 the leaf length 6</p> <p>5. Leaves cuspidate, the cuspid reddish, less than 1/5 the leaf length 8</p> <p>6(5). Leaves with hair-point hyaline throughout, apical leaf cells linear, hyaline <i>B. niveum</i> Bescherele</p> <p>6. Leaves with hair-point hyaline in upper half, reddish brown below, apical leaf cells hexagonal to rhomboidal-hexagonal, concolorous 7</p> <p>7(6). Capsules narrowly cylindrical, 3–5 μm long; upper leaf margins toothed to sharply serrate or denticulate <i>B. morascium</i> Bescherele</p> <p>7. Capsules obovate-oblong, 2.5–4 mm long, upper leaf margins entire to weakly serrulate <i>B. systylium</i> (C. Müller) Jaeger</p> <p>8(5). Leaves ovate to oblong-lanceolate, 1.4–2.3 mm long; basal leaf cells quadrate to subquadrate; plants without axillary bulbils; capsules cylindrical, endostome cilia/segments rudimentary or absent
 <i>B. mexicanum</i> Montagne</p> <p>8. Leaves ovate, lanceolate, or elongate-triangular, 2–3 mm long; basal leaf cells short-rectangular to subquadrate; plants often with axillary bulbils; capsules globose, endostome cilia/segments well developed, opposite the exostome teeth
 <i>B. columbicum</i> (De Notaris) Brotherus</p> <p>9(4). Basal leaf cells quadrate 10</p> <p>9. Basal leaf cells rectangular 12</p> <p>10(9). Leaves twisted around the stem, shortly and stoutly awned, awn reddish throughout, to 0.2 mm long; leaf border often of narrow rectangular cells with ± right-angled end-walls</p> | <p>(occasionally with tapered end-walls); upper leaf margins crenulate to serrulate; leaf margins often narrowly reflexed
 <i>B. klotzschii</i> (Schwaegrichen) Paris</p> <p>10. Leaves imbricate, hair-pointed, the hair point hyaline throughout or hyaline above, reddish below, 0.5–1 mm long; leaf border of linear cells with long tapered end-walls; upper leaf margins toothed or sharply serrate to denticulate; leaf margins plane above 11</p> <p>11(10). Leaves with hair-point hyaline throughout, apical leaf cells linear, hyaline
 <i>B. niveum</i> Bescherele</p> <p>11. Leaves with hair-point hyaline in upper half, reddish brown below, apical leaf cells hexagonal to rhomboidal-hexagonal, concolorous <i>B. morascium</i> Bescherele</p> <p>12(9). Setae to 65 mm long; capsules to 7 mm long; capsules with unicellular spores (40–56 μm) and linear, multicellular, endosporic protonemata (240–320 × 56 μm)
 <i>B. exoticosporum</i> B. H. Allen</p> <p>12. Setae to 30 mm long; capsules to 5 mm long; spores unicellular (10–80 μm), multicellular, endosporic protonemata absent 13</p> <p>13(12). Plants large, to 30–40 mm long; leaves flexuous and appressed to stem when dry, oblong to oblong-lanceolate; upper leaf cells 80–120 μm long
 <i>B. speciosum</i> (Hooker f. & Wilson) Steere</p> <p>13. Plants medium, to 15 mm long; leaves spirally contorted or crisped and contorted when dry, elongate-oblong, obovate-oblong to spatulate (rarely oblong-lanceolate); upper leaf cells 30–60 μm long 14</p> <p>14(13). Leaves crisped and contorted when dry, often orbicular, obtuse to shortly and broadly acuminate
 <i>B. wrightii</i> (Sullivan) Brotherus</p> <p>14. Leaves spirally twisted when dry, variously lanceolate, oblong, obovate-oblong, spatulate, acute to acuminate 15</p> <p>15(14). Leaf margins nearly entire to finely serrulate at the apex; operculum high-conic and obliquely beaked; exostome teeth linear
 <i>B. spirifolium</i> (C. Müller) Jaeger</p> <p>15. Leaf margins sharply serrulate or denticulate in upper 1/3; operculum conic to conic-apiculate; exostome teeth linear-lanceolate to lanceolate 16</p> <p>16(15). Exostome teeth broadly lanceolate, united at base; endostome segments and cilia rudimentary or with endostomal material adhering in patches to the upper parts of the exostome teeth <i>B. consimile</i> (Mitten) Jaeger</p> <p>16. Exostome teeth linear-lanceolate, free at base; endostome segments absent, rudimentary, or well developed 17</p> <p>17(16). Endostome segments rudimentary or absent;</p> |
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- spores irregular in shape, spherical, ovoid, or oblong, 20–80 μm *B. standleyi* Bartram
17. Endostome segments well developed, linear with narrow perforation gaps; spores spherical, 22–30 μm
 *B. radiculosum* (Schwaegrichen) Hampe

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